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ABSTRACT

Based on a followup study of graduates from a two-year training program for Physician Assistants in Diagnostic Radiology (PA-DR) at the University of Kentucky Medical Center, results are presented of an evaluation of the first year of postgraduate work activities of the initial two classes (twelve students) in nine different radiological work environments. Data summaries are presented under four headings representing four characteristics of the PA-DRs' performance: (1) work activity time measurements; (2) type and number of examinations conducted and films screened; (3) economic impact; and (4) acceptability to professional associates and to patients. Focus was not only on assessment of the success of the program, but also on the technical competency of the graduates and on whether they were employed in a manner consonant with their training. Conclusions listed include the following: PA-DRs devoted a high percentage of their time to activities which were in keeping with their training; their employment by a radiologist is financially worthwhile; the PA-DRs's on the average saved thirty-four percent of a radiologist's time; and their acceptability by professional colleagues remarkably high. The statement of overall assessment is that the activities of PA-DRs improved the utilization of radiologic manpower. Data tables and the rating report are appended. (VB)

NCHSR

RESEARCH DIGEST SERIES

An Evaluation of Physician Assistants in Diagnostic Radiology

Brian Kiernan, M.S., and
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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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ABSTRACT

This project demonstrates a method to improve utilization of radiologic manpower by developing a program that would train selected, highly motivated, registered radiologic technologists to assume many duties which are currently the sole responsibility of physician radiologists. A two-year curriculum was developed to train radiologic technologists and to provide on-the-job experience (rotational externships) in radiology offices in both urban and rural settings. This training and experience enabled the radiologic technologists to better assist the physician radiologist in departmental administration, to perform fluoroscopic gastrointestinal examinations, to assist in angiographic studies, and particularly to differentiate between normal and abnormal roentgenograms.

This *NCHSR Research Digest* was written by Brian Kiernan, M.S., and H.D. Rosenbaum, M.D. Mr. Kiernan, formerly with Spindletop Research, is presently with the Kentucky Legislative Research Commission, Frankfort, Kentucky. Dr. Rosenbaum is Professor and Chairman, Department of Diagnostic Radiology, University of Kentucky Medical Center, Lexington, Kentucky. This investigation was supported by the National Center for Health Services Research under grants RM 00048-02A2 and HS 00567.

This issue summarizes evaluation portions of the final report, "Project to Improve Utilization of Radiologic Manpower," available for sale to the public by the National Technical Information Service, Springfield, VA 22161 (tel.: 703/557-4650), order no. PB 253 285.

Copies of this Digest are available on request to NCHSR, Office of Scientific and Technical Information, 5600 Fishers Lane, room 15-30, Rockville, MD 20857 (tel.: 301/443-2800).

Other NCHSR reports of related interest are *Program Analysis of Physician Extender Algorithm Projects,* (HRA) 77-3160, and *Nurse Practitioner and Physician Assistant Training and Deployment,* (HRA) 77-3173, also available on request.

FOREWORD

For a number of years, many training programs have been established in an effort to provide additional mid-level health manpower to fill the gaps in the delivery of health services in ambulatory care settings. The National Center for Health Services Research has assisted this endeavor by supporting projects to evaluate the impact of allied health personnel such as physician assistants, nurse practitioners and dental auxiliaries.

The program to train and evaluate advanced radiologic technologists is one such project. From March 1971 to September 1975, the National Center for Health Services Research supported this effort to improve utilization of radiologic manpower. This Digest contains a condensed version of the evaluation portion of the final report. It provides information that is new and should be of interest to many individuals and organizations in the health field, as well as public health officials and radiologic technology associates.

Gerald Rosenthal, Ph.D.
Director
National Center for Health Services Research

March 1977

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INTRODUCTION

The concept of Physicial Assistants emerged in the 1960s as a possible way to alleviate a shortage of physicians. This concept led to the initiation in 1970 of a two year training program for Physician Assistants in Diagnostic Radiology (PA-DR) at the University of Kentucky Medical Center. It was hoped that the activities of properly trained PA-DRs would improve the utilization of radiologic manpower. Course materials were developed, students were selected and trained, and finally the activities of the initial graduates have been evaluated in radiological work environments. A detailed description of the development and scope of the program has been published by Rosenbaum et al [1,2] and by Huber [3]. This paper presents the results of the evaluation of the first year of postgraduate work activities of the initial two classes (twelve students) in nine different radiological work environments.

The work environments encompassed a wide range of Radiology departments, including a health maintenance organization (HMO), various hospitals ranging from community size to a major medical center, several clinics and a highly active private practice. The graduate PA-DRs, therefore, experienced a wide range of working conditions and were exposed to a variety of patient work loads. In addition, they held positions of varying status within the work environments.

The evaluations focused upon four important characteristics of the PA-DRs' performance: (1) work activity time measurements; (2) type and number of examinations conducted and films screened; (3) economic impact; and (4) acceptability to professional associates and to patients. The evaluations were designed not only to assess the success or otherwise of the program but also to measure the technical competency of the graduates and to determine whether they were employed in a manner consonant with their training, which was specifically designed to maximize the radiologic health care they delivered.

METHOD OF EVALUATION

The basic instrument used to evaluate the work characteristics experienced by the graduate PA-DRs was a daily activity log which was kept by each graduate according to detailed and specific instructions. The daily activity log required that all work tasks be described and that the amount of time devoted to each be quantitated to the nearest half hour. Specific emphasis was placed upon recording the types of radiological examinations conducted exclusively by the PA-DR in contrast to examinations during which the PA-DR graduate performed the role of a radiologic technologist.

It was recognized that the potential existed for misrepresentations by the graduates. Consequently, the data were analyzed with considerable cross-referencing so significant discrepancies would become apparent. None were noted. This detailed analysis was supplemented by random inspections of departmental records and by interviews with the employing radiologists. The daily activity log and the other means described proved to be highly satisfactory due to exceptional cooperation by the graduates and by other members of the various Radiology departments.

The primary method used to obtain information concerning the acceptability of the PA-DR graduates to colleagues, and indirectly to patients, was a graphic rating report (Figure 1). This document, which is basically a finely graduated two-paged questionnaire, was administered at intervals during the evaluation. It previously had been very thoroughly tested during the academic training of the graduates. It was used at that time to monitor their performance during various internships.

RESULTS

The following is a summary of the data obtained. The condensation for publication necessarily resulted in the loss of a certain amount of refinement.

Work Activity Time Measurements

The work activity data for Class I and Class II PA-DR graduates are shown in Tables I and II, respectively. The work activities were divided into the following eight categories.

1. Administration: Time specifically devoted to administering the Radiology Department. The time needed to perform normal departmental paper work is not included.
2. Conducting Examinations: This includes only the time devoted to conducting examinations which normally would be performed by a radiologist.
3. Screening Films: The time spent screening films into positive and negative categories. Viewing films for other reasons such as quality control was not included.
4. Teaching/Education: This covers both time spent teaching technicians, students, etc., and time spent by the graduate PA-DRs furthering their own education. This category also includes conferences, technical research, reading journals, etc.
5. X-Ray Technologist Duties: Time spent specifically in the usual activities of a radiologic technologist.
6. Miscellaneous Activities: All activities which individually were insufficient to justify a separate category. This may account for up to 25 percent of the time of the professional staff in various fields.
7. Vacation/Personal.
8. Quality Control: Time spent specifically monitoring the quality of radiographs produced by other staff persons in the Radiology Department.

The two work activity categories which specifically characterize the Physician Assistant's role in Diagnostic Radiology are conducting examinations and screening films. It can be seen from Table I that four of the six PA-DR graduates of Class I devoted 49 percent or more of their time to these two activities. Class II

graduates were even more outstanding, with all six spending more than 50 percent of their time either conducting examinations or screening films. The least amount of time for both classes recorded for these activities was in the same work environment, a Veterans Administration Hospital (VAH). This result is believed to be due partly to the nature of the VAH and also to the fact that the installation was relatively new and consequently was not functioning at full capacity.

No distinctive patterns emerged concerning the effect of the type of environment on the work activity characteristics. There was, however, some indication that community hospitals, both small and medium-sized, tended to utilize the graduates more extensively in their proper role as Physician Assistants.

X-ray technologist duties were considered the least effective use of the graduates for, indeed, they had all performed in this role prior to becoming trained as PA-DRs. Only in the VAH were they extensively employed in this activity, accounting for over 20 percent of their time. Class II graduates fared better than their predecessors in this respect, with only two performing any x-ray technologist duties compared to four in Class I.

In only three work environments (a private clinic, an HMO and the VAH) did the graduates have significant administrative duties. This is contrasted to quality control which, although partly supervisory in nature, was a significant activity for six of the twelve PA-DR graduates.

The most even distribution of work activities was achieved in the HMO. While this could be coincidence, it came as no great surprise because the design and nature of HMOs seem in many ways an ideal location for a PA-DR.

Examinations Conducted and Cases Screened

The primary functions of a PA-DR are to conduct examinations and to screen radiographs for evidence of significant disease. While the success of the program is also dependent upon other important factors such as professional acceptability and economic impact, the PA-DR does not exist in fact until he conducts examinations and screens radiographs, activities which previously have been exclusively the responsibility of a radiologist. Only in this way will the utilization of radiologic manpower be improved over that which existed before they were trained to become PA-DRs.

In collecting data on the examinations conducted by the graduates, care was taken to exclude examinations in which the PA-DRs were performing the role of a radiologic technologist. Similarly, the data on cases screened exclude the viewing of radiographs for quality control. Shown in Tables III and IV are the number of cases screened and the number of examinations performed (including the types of examinations involved) by the twelve PA-DRs. Data on cases screened refers to the number of patients and not to the number of films which often were three or more per patient.

It can be seen from Tables III and IV that the examination mix varied considerably from graduate to graduate although some general characteristics are evident. By far the most frequent examination was an upper gastrointestinal study followed by barium enemas and, somewhat less often, intravenous urograms and cholecystograms.

The total number of examinations conducted by the Class I graduates varied markedly with a high figure of just under 4,000 examinations by Graduate A and a

low figure of 292 by Graduate F. A marked variation occurred in the number of cases screened. The average was more than 5,000 cases with the lowest recorded figure being 2,174 cases and the highest 7,267.

Table IV shows that Class II graduates performed a significantly larger number of examinations. They also screened a considerably higher number of cases than did Class I graduates. Table IV clearly demonstrates that the Class II PA-DRs were utilized in a manner more nearly in keeping with their training. It is probable that the three who worked in institutions that had employed Class I graduates were benefitted from the confidence established by their predecessors. The employing radiologists appeared to be more inclined to delegate a greater amount of responsible work to Class II graduates.

Economic Impact

A variety of methods are available to obtain a measure of the economic impact of PA-DRs; however, the constraints inherent in the various medical environments on the data requirements of many approaches greatly narrow the choices. The following two methods were considered. First, under favorable conditions it might be possible to measure an increase in patient load which could be directly attributable to the PA-DRs and then to assign a dollar value to such increases. An alternative approach is to analyze work activities using classical industrial engineering techniques, assigning hour/dollar values to each major work activity. Ideally, a combination of both methods would yield the most meaningful data with each method acting as a check on the other. Unfortunately, evaluation of economic impact as evidenced by an increased patient work load is not accurate for the following reasons.

1. The activities of a Radiology Department are primarily service oriented. Radiology departments do not generate their own patients. Thus, the provision of faster and better service is not necessarily reflected in an increased patient load.
2. Six of the nine work environments were hospitals where "market place" economics do not operate.
3. Even in clinics and in a private practice, which tend to operate somewhat more nearly along commercial lines, it is impossible to ascribe an increase in the number of patients directly to the presence of a PA-DR. Other factors, such as new equipment, improved scheduling, modification in procedures, population changes, etc., are just as likely to be responsible.

Thus, in the context of PA-DRs the most readily available method of obtaining a measure of economic impact is by analyzing their work activities and then assigning a dollar value to each. While there are arbitrary aspects to this approach, it is logical and does allow for meaningful comparisons to be made between different work environments and between different radiological allied health personnel such as chief technologists, staff technologists, etc.

Theoretical "revenue" generated by each graduate was calculated by first adjusting the work activities reported in Tables I and II from eight to six

categories by distributing the Vacation/Personal and Miscellaneous times in the following manner:

$$\text{Adjusted time} = \text{Actual time} + 1/6\ \text{Miscellaneous} + 1/6\ \text{Vacation/Personal}$$

From a detailed analysis of the work activities and by reference to a generalized model for hospital microcosting [4], it was established that the graduate PA-DRs functioned as one of the following four professional designations: radiologist, chief radiologic technologist, administrative radiologic assistant, and staff radiologic technologist. Salaries for a chief technologist, an administrative radiologic assistant and a staff radiologic technologist were set at $14,000, $18,000 and $11,000 respectively. These data were obtained from information published by the American Society of Radiologic Technologists [5]. No reliable data exist on the income of radiologists. It was arbitrarily decided to use a yearly salary of $60,000 in the calculations. It is believed that all of the salary estimates are conservative.

The six adjusted categories of work activities were then divided among the four professional designations in the following manner. These divisions are also viewed as conservative and consequently tend to result in a low calculated generated "revenue".

1. Administration: All time devoted to this activity was calculated as an administrative radiologic assistant.

2. Conducting Examinations: Based upon analysis of the types of examinations conducted and other data [4], time conducting examinations was divided as follows: 50 percent as a radiologist, 25 percent as an administrative radiologic assistant, 25 percent as a chief radiologic technologist.

3. Screening Films: Based upon an analysis of the examinations conducted and the work activities of each PA-DR, 50 percent of this activity was designated as the function of a radiologist and 50 percent as an administrative radiologic assistant.

4. Teaching/Education: 50 percent of the time devoted to this activity was assigned as the duties of a chief radiologic technologist and 50 percent as that of an administrative radiologic assistant.

5. X-Ray Technologist Duties: All time devoted to this activity was obviously that of a staff radiologic technologist.

6. Quality Control: Time spent in this activity was divided equally between the duties of a chief radiologic technologist and an administrative radiologic assistant.

Theoretical generated "revenue" was then calculated on the basis of a standard work year of 2,080 hours by using the following simple formula:

Theoretical "revenue" generated = 2080 x percent time as radiologist x radiologist hourly rate ($28.35)

+

2080 x percent time as administrative radiologic assistant x hourly rate ($8.65)

+

2080 x percent time as chief radiologic technologist x hourly rate ($6.70)

+

2080 x percent time as staff radiologic technologist x hourly rate ($5.30)

The results of these calculations are shown in Tables V and VI together with the equivalent amount of the radiologists' time that was saved by the PA-DRs. The caluclated "revenues" for the Class I graduates ranged from a low of $19,862 in the VAH to a high of $37,495 in a suburban hospital. The average was $29,695.

The generated "revenues" for the Class II graduates were significantly higher than those of Class I with a low, again in the VAH, of $28,536 and a high of $37,350 in a medium large community hospital. The average was $32,634.

The average calculated generated "revenues" for all twelve graduates was $31,164 which indicates employment of a PA-DR by a radiologist at a salary of $20-25,000 is profitable. Thompson [6] in 1974 reported actual salaries for radiology physician associates to be in the range of $15-25,000 with an average of $19,221 for eight associates. Taking a very different approach toward estimating the financial impact of primary care physician assistants, Nelson et al [7] reported an average of $30,210 in generated revenues per graduate. A second method, similar to that used in this paper, resulted in an average revenue of $28,190 per graduate. When allowance is made for the fact that Nelson's data include a deduction for overhead expenses caused by the physician assistant which mostly does not apply in Diagnostic Radiology, the indication is that the data presented in this report are highly conservative. Indeed, Miles [8] has suggested that Nelson's calculations understate the financial value of a physician assistant.

Acceptability to Professional Associates and to Patients

An important concern relative to the activities of a PA-DR is professional acceptability. Acceptance of the graduates by radiologists, other physicians, other allied health professionals and by patients was determined insofar as the constraints of the work environments permitted. Measurement of patient acceptability was particularly difficult because all of the graduates were working in a dynamic medical situation where classical acceptability experiments could not be conducted. Indeed, the viability of the entire program would have been jeopardized by the operational problems that would have been created in the work environment by distributing a sensitive questionnaire.

The approach taken was to directly question the professional associates of the PA-DRs. A graphic rating report (Figure 1) was selected as the questionnaire. It was felt that this was more likely to be completed than one which required long written answers. Experience proved this to be true. The graphic rating report lists 14 qualities, and offers the respondent five descriptive terms for each. He is asked to

indicate with a check mark where on the scale he rates the graduate being graded. Each quality was explained to the respondent and he was informed of the criteria to be used in answering the questions.

To quantify the responses, each answer on the report was graded between zero and ten. The respondents were not aware their ratings would be quantified. Consequently, the answers related directly to the adjectives presented. This was considered to be beneficial because respondents are less likely to give an unearned high mark with adjectival scoring than with numerical scoring.

A summary of the evaluations for Class I is shown in Table VII. The percent of maximum points scored varied from a low of 84.5 for Graduate D to 97.1 for Graduate C. While this is a relatively narrow range it does distinguish among the PA-DRs. A score of 97.1 indicates an extremely high level of acceptability; however, 84.5 is not excessively low. On the contrary, a performance at this level is distinctively better than satisfactory. The scores for Class II, listed in Table VIII, show similar results.

In summary, the performances of the graduates were highly acceptable to their professional colleagues. Question 8 on the rating form specifically related to patient acceptance. Only three PA-DRs scored less than 90 percent on this question. The lowest score for patient acceptability was 73 percent by Student D of Class I. A 70 percent score corresponds to a point halfway between "considered courteous" and "no detectable response".

CONCLUSIONS

The results of this evaluation show that the PA-DRs devoted a high percentage of their time to activities which were in keeping with their training. Screening films and conducting examinations constituted 49 percent or more of the activities of ten of the twelve PA-DRs.

During their one year of evaluated work experience, the PA-DR graduates of Class I conducted a substantial number of examinations, ranging from a low of 292 to a high of 3,975. The average was 1,615. The performance of the second class of PA-DRs was even more impressive with an average of 2,910 examinations and a high of 6,468. The number of cases screened for evidence of pathology varied from a low of 2,174 to a high of 10,043, with an average of 5,754.

The economic impact of the PA-DRs, measured in terms of calculated generated "revenue", ranged from $19,862 per year in a VAH to $37,495 in a medium-sized suburban hospital. The average calculated generated "revenue" for all twelve PA-DRs was $31,164 which clearly indicates that their employment by a radiologist at salaries in the $20 to 25,000 range is financially worthwhile. The economic data also yield information on the percentage of a radiologist's time that is saved by utilizing a PA-DR. The data indicate that, on the average, the PA-DRs saved 34 percent of the radiologist's time. This amounts to almost 90 working days in a typical work year.

Quantitation of the professional acceptability and patient/PA-DR relationships was obtained from the answers provided by 73 of their professional colleagues to a questionnaire containing 14 specific questions. The average score for all of the PA-DRs on a maximum 100 point scale was 91, showing a remarkably high acceptance level. No PA-DR obtained a lower average score than 82.4 for all 14 questions. One graduate exceeded 98 on the 100 point scale, indicating an extremely high acceptance level.

The overall assessment of all the data obtained suggests that the activities of PA-DRs improve the utilization of radiologic manpower.

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Figure 1: Graphic Rating Report.

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GRAPHIC RATING REPORT ON ART STUDENTS

Name of Student _____ **Hospital/Clinic** _____

Immediate Supervisor _____ **Department** _____

Student Rated By _____ **Date** _____

INSTRUCTIONS FOR MAKING OUT THIS REPORT: Rate this student on the basis of the actual work he is now doing. Before attempting to report on this student, it is necessary to have clearly in mind the exact qualities which are to be reported on. Read the definitions very carefully. Place a check (✓) somewhere on the line running from "very high" to "very low" to indicate this student's standing in each quality. It is not necessary to put the check (✓) directly above any of the descriptive adjectives.

QUALITIES	REPORT				
I **Ability to Learn**: Consider the ease with which this student is able to learn new methods and to follow directions given him.	Very Superior	Learns With Ease	Ordinary	Slow to Learn	Dull
II **Quantity of Work**: Consider the amount of work accomplished and the promptness with which work is completed.	Unusually High Output	Satisfactory Output	Ordinary	Limited Output	Unsatisfactory Output
III **Quality of Work**: Consider the neatness and accuracy of his work and his ability constantly to turn out work that is up to standard.	Highest Quality	Good Quality	Ordinary	Careless	Makes Many Errors
IV **Industry**: Consider his energy and application to the duties of his job day in and day out.	Very Energetic	Industrious	Ordinary	Indifferent	Lazy
V **Initiative**: Consider his success in going ahead with a job without being told every detail, his ability to make practical suggestions for doing things in a new and better way.	Very Original	Resourceful	Occasionally Suggests	Routine Worker	Needs Constant Supervision
VI **Co-operativeness**: Consider his success in effectively co-operating with his co-workers and with those exercising greater authority.	Highly Co-operative	Co-operative	Moderate	Difficult to Handle	Obstructionist
VII **Knowledge of Work**: Consider present knowledge of job and of work related to it.	Complete	Well Informed	Moderate	Meagre	Lacking

QUALITIES	REPORT				
VIII **Patient Relationship**: Consider his success in dealing with patients, with emphasis on how patients respond to his manner.	Highly Pleased	Considered Courteous	No Detectable Response	Occasional Displeasure	Offends
IX **Professional Acceptability**: Consider his success in winning confidence and respect from professional staff through his personality and technical competence.	Highly Acceptable	Favorable	Indifferent	Unfavorable	Highly Unacceptable
X **Technical Competency**: Consider his abilty to perform the following tasks:					
a) Ability to take radiographs.	Superior	Good	Ordinary	Careless	Makes Many Errors
b) Ability to perform injections–IVP & IVC.	Superior	Good	Ordinary	Careless	Makes Many Errors
c) Ability to perform fluroscopy procedures.	Superior	Good	Ordinary	Careless	Makes Many Errors
d) Ability to monitor quality control of X-ray examinations.	Superior	Good	Ordinary	Careless	Makes Many Errors
e) Ability to screen radiographs; i.e., to differentiate between positive and negative films.	Superior	Good	Ordinary	Careless	Makes Many Errors

REMARKS _____

_____

_____

_____

_____

_____

Signed by _____ **Date** _____

Table I: Data on Work Activities for Class I

Graduate	Admin. %	Conducting Examinations %	Screening Films %	Teaching/ Education %	X-Ray Tech's Duties %	Misc. Activities %	Vacation/ Personal %	Quality Control %	Total Hours Worked
A	-	56	35	-	-	3	6	-	1915
B	1	32	41	-	12	12	2	-	1878
C	54	9	8	4	23	-	2	-	2429
D	29	16	12	-	-	3	6	34	1566
E	-	29	24	-	8	20	10	9	1921
F	-	13	36	15	2	17	11	6	1889

A. Medium-sized suburban hospital
B. Small community hospital/clinic
C. Veterans Administration Hospital [VAH]
D. Medium-sized private clinic
E. Private radiology practice
F. University Hospital

Table II: Data on Work Activities for Class II

Graduate	Admin. %	Conducting Examinations %	Screening Films %	Teaching/ Education %	X-Ray Tech's Duties %	Misc. Activities %	Vacation/ Personal %	Quality Control %	Total Hours Worked
G	-	48	27	-	-	10	4	11	1881
H	-	31	50	3	-	3	13	-	1764
I	-	31	21	-	22	2	8	16	1990
J	18	18	44	14	2	-	4	-	1840
K	2	39	19	-	-	19	11	10	2015
L	-	53	35	-	-	1	11	-	2190

G. Medium-sized suburban hospital [Same location as A of Class I]

H. Small community hospital/clinic [Same location as B of Class I]

I. Veterans Administration Hospital [VAH] [Same location as C of Class I]

J. Health Maintenance Organization [HMO]

K. Small community hospital

L. Medium-large community hospital

Table III: Data on Examinations Conducted and Cases Screened by Class I

Graduate	Total Exams	Upper GI Exams	Barium Enemas	Esopho-grams	Cholecys-tograms	IV Urograms	Misc. Exams	Cases Screened
A	3975	1417	955	91	722	344	446	6927
B	1715	1015	575	10	33	75	7	6623
C	763	388	206	1	70	93	5	2816
D	932	365	189	17	215	143	3	2174
E	2015	555	247	27	412	375	399	5347
F	292	184	77	-	8	4	19	7267

A. Medium-sized suburban hospital
B. Small community hospital/clinic
C. Veterans Administration Hospital [VAH]
D. Medium-sized private clinic
E. Private radiology practice
F. University Hospital

Table IV: Data on Examinations Conducted and Cases Screened by Class II

Graduate	Total Exams	Upper GI Exams	Barium Enemas	Esopho-grams	Cholecys-tograms	IV Urograms	Misc. Exams	Cases Screened
G	4345	1765	1315	61	471	675	58	2339
H	1441	851	533	5	36	6	10	7947
I	1423	679	322	47	205	33	147	5617
J	785	286	142	39	111	181	26	10043
K	2982	1421	722	41	210	440	148	6194
L	6468	2099	1366	80	1222	1229	472	No reliable data

G. Medium-sized suburban hospital [Same location as A of Class I]

H. Small community hospital/clinic [Same location as B of Class I]

I. Veterans Administration Hospital [VAH] [Same location as C of Class I]

J. Health Maintenance Organization [HMO]

K. Small community hospital

L. Medium-large community hospital

Table V: Calculated "Revenues" Generated by Class I PA-DR Graduates

GRADUATE	Calculated "Revenue"	Equivalent Percent of Radiologist's Time	Equivalent Radiologist's Hours Per Week [40 Hours Base]
A	$37,495	48.1	19.2
B	$35,057	44.0	17.6
C	$19,862	8.2	3.3
D	$25,499	19.6	7.8
E	$30,361	33.7	13.5
F	$29,899	31.3	12.5
Averages	$29,695	31.1	12.3

A. Medium-sized suburban hospital
B. Small community hospital/clinic
C. Veterans Administration Hospital [VAH]
D. Medium-sized private clinic
E. Private radiology practice
F. University hospital

Table VI: Calculated "Revenues" Generated by Class II PA-DR Graduates

GRADUATE	Calculated "Revenue"	Equivalent Percent of Radiologist's Time	Equivalent Radiologist's Hours Per Week [40 Hours Base]
G	$34,955	42.4	17.0
H	$36,385	45.5	18.2
I	$23,536	20.3	8.1
J.	$29,211	28.9	11.6
K	$34,369	40.6	16.2
L	$37,350	47.7	19.1
Averages	$32,634	37.6	15.0

G. Medium-sized suburban hospital
[Same location as A of Class I]
H. Small community hospital/clinic
[Same location as B of Class I]
I. Veterans Administration Hospital [VAH]
[Same location as C of Class I]
J. Health Maintenance Organization [HMO]
K. Small community hospital
L. Medium-large community hospital

Table VII: Summary of Evaluations of Class I PA-DR Graduates

Graduate	A	B	C	D	E	F
Number of Evaluators	8	16	3	3	3	
Evaluation Criteria						
1. Ability to learn	9.0	8.9	10.0	8.0	8.0	
2. Quantity of work	9.4	8.3	9.3	8.5	9.3	
3. Quality of work	9.6	9.0	10.0	9.8	10.0	
4. Industry	9.4	9.7	10.0	8.3	8.0	
5. Initiative	9.1	8.9	10.0	9.0	8.7	
6. Cooperativeness	8.9	9.4	9.3	7.3	9.3	
7. Knowledge of work	9.5	9.5	9.3	9.0	9.3	
8. Patient relationship	9.4	9.0	10.0	7.3	8.7	
9. Professional acceptability	9.1	9.4	10.0	7.8	9.3	
10. Ability to take radiographs	9.6	9.0	10.0	8.3	9.3	
11. Ability to perform injections	9.6	9.2	9.3	8.7	9.3	
12. Ability to perform fluoroscopy	9.5	9.1	9.3	7.7	9.3	
13. Ability to monitor quality control	9.8	8.8	10.0	9.7	8.7	
14. Ability to screen radiographs	9.3	9.7	10.0	9.3	8.0	
Total Average Score	131.2	127.9	136.0	118.7	125.2	
Percent of Maximum	93.7	91.4	97.1	84.5	89.4	
Rank of Student	2	3	1	5	4	

[No evaluators available who were not instructors in the training program]

Table VIII: Summary of Evaluations of Class II PA-DR Graduates

Graduate	G	H	I	J	K	L
Number of Evaluators	4	4	8	10	10	4
Evaluation Criteria						
1. Ability to learn	8.3	8.0	9.0	9.2	9.0	10.0
2. Quantity of work	7.5	8.0	9.4	9.8	9.1	9.8
3. Quality of work	8.0	8.0	9.1	9.4	9.6	9.8
4. Industry	7.8	7.5	9.4	10.0	9.4	10.0
5. Initiative	6.5	7.5	9.5	9.5	9.0	10.0
6. Cooperativeness	8.8	9.3	10.0	9.7	9.6	10.0
7. Knowledge of work	8.8	8.3	8.6	9.4	8.9	9.8
8. Patient relationship	8.5	9.0	9.6	9.3	9.2	9.8
9. Professional acceptability	9.0	9.5	9.5	9.8	9.7	9.8
10. Ability to take radiographs	8.3	8.7	9.1	9.7	9.4	9.3
11. Ability to perform injections	8.8	9.0	9.4	10.0	9.4	10.0
12. Ability to perform fluoroscopy	8.8	9.0	9.5	9.7	9.8	10.0
13. Ability to monitor quality control	8.5	8.5	8.4	9.8	9.8	10.0
14. Ability to screen radiographs	7.7	8.5	9.3	9.7	9.5	9.5
Total Average Score	115.3	118.8	129.8	135.0	131.4	137.8
Percent of Maximum	82.4	84.9	92.7	96.4	93.9	98.4
Rank of Student	6	5	4	2	3	1

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15. Supplementary Notes See NTIS Report PB 253 285, entitled: "Project to Improve Utilization of Radiologic Manpower," for final report of this Digest.

16. Abstracts

This project demonstrates a method to improve utilization of radiologic manpower by developing a program that would train selected, highly motivated, registered radiologic technologists to assume many duties which are currently the sole responsibility of physician radiologists. A two-year curriculum was developed to train Radiologic Technologists (PA-DR's) and to provide on-the-job experience (rotational externships) in radiology offices in both urban and rural settings. This training and experience enabled the PA-DR's to better assist the physician radiologist in departmental administration, to perform fluoroscopic gastrointestinal examinations, to assist in angiographic studies, and particularly to differentiate between normal and abnormal roentgenograms.

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